

Lymphatic System

Tissues and Organs Involved in the Immune System Response

Lymphoid Tissues and Organs

The immune system is organized on several special tissues, called lymphoid or immune tissues. Some lymphoid tissues have a remarkable degree of organization called as **lymphoid organs**. The **lymph nodes** are the most important and are located in groups along major blood vessels and loose connective tissues. Other mammalian lymphoid organs are the **thymus** and the **spleen** (white pulp). Lymphoid tissues include the **gut-associated lymphoid tissues (GALT)**—tonsils, Peyer's patches, and appendix—as well as aggregates of lymphoid tissue in the submucosal spaces of the respiratory and genitourinary tracts.

Lymphoid tissues can be subdivided into primary and secondary as follow:

A. Primary Lymphoid Tissues:

Lymphoid tissues have the ability to produce cells of the lymphocytic lineage, which is the characteristic of primary lymphoid tissues.

1. Bone Marrow

It is a flexible tissue in the interior of bones. It produces RBCs by the cores of bone marrow in the heads of long bones in a process known as **hematopoiesis**. On average, bone marrow constitutes 4% of the total body mass of humans; in an adult weighing 65 kilograms. The hematopoietic component of bone marrow produces approximately 500 billion blood cells per day. Bone marrow is a key component of the lymphatic system, producing the lymphocytes and other cells of the immune system via stem cells,

Physiological role. Moreover production of blood cells, the red bone marrow is a key element of the lymphatic system, it generates lymphocytes from

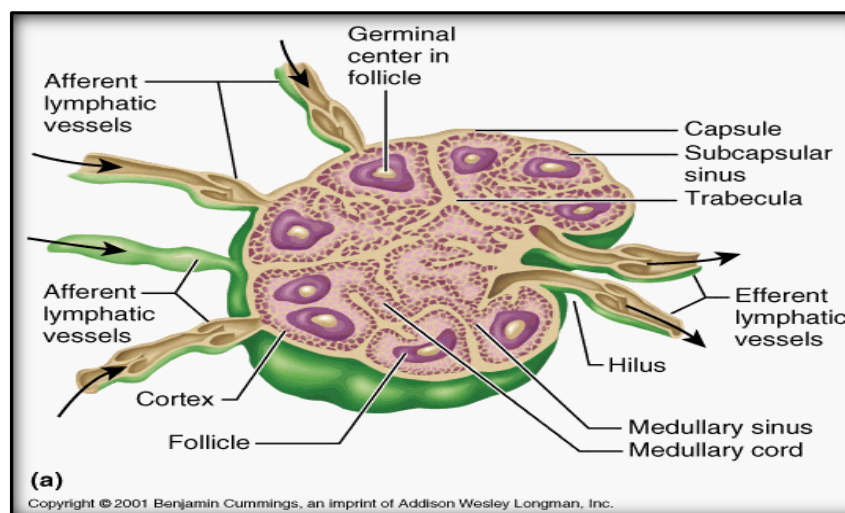
immature hematopoietic progenitor cells. The bone marrow and thymus constitute the primary lymphoid tissues involved in the production and early selection of lymphocytes. Furthermore, bone marrow performs a valve-like function to prevent the backflow of lymphatic fluid in the lymphatic system. Other important role is maturation and differentiation of B-lymphocytes.

2. Lymph Nodes.

The lymph nodes are many and distributed all over the body. They measure 1 to 25 mm in diameter and play a very important role in the initiation of the immune response.

Anatomical organization. The lymph nodes are circled by a connective tissue capsule and open into the subcapsular sinus. The lymph node also receives blood from the systemic circulation through the hilar arteriole. Two main regions can be distinguished in a lymph node: the cortex and the medulla. The **cortex** and the **deep cortex** (also known as **paracortical area**) contain many lymphocytes, the cortex also containing packed lymphocytes and termed **follicles** or **nodules**.

Physiological role. The lymph nodes can be compared to a network of filtration and communication stations where antigens are trapped and messages are transmitted between the different cells involved in the immune response. Also have an important role during secondary immune responses.



(Lymph Nodes Anatomy)

Langerhans cells of the dermis. Those cells express MHC-II molecules, and therefore function as APC, they migrate from the dermis to the paracortical

areas, where they interact with the T lymphocytes and helper T lymphocytes to specifically recognize those MHC-associated peptides in APC which is essential for proper initiation of the immune response.

3. Thymus

The thymus is a primary lymphoid organ in mammals. It is believed to play a key role in determining the differentiation of T lymphocytes.

Anatomical organization. The thymus is located in the superior mediastinum, anterior to the great vessels. It has a connective tissue capsule, which divide the organ into lobules. Each lobule has a **cortex** and **medulla**, and coated with epithelial cells.

a. Cortex.

Lymphocyte aggregates, composed mainly of immunologically immature T-lymphocytes, are located in the cortex where these cells proliferation occurs. A small number of macrophages and plasma cells are also present. In addition, the cortex contains epithelial cells.

b. Medulla.

Not as densely as the cortex, the medulla contains predominantly mature T-lymphocytes, and has a larger epithelial cell-to-lymphocyte ratio than the cortex and the squamous epithelial cells known as **Hassall's corpuscles**.

Physiological roles:

- a. **T-lymphocyte differentiation.** The thymus is believed to be the organ where T-lymphocytes differentiate during embryonic life. The Thymic cortex is an area of cell proliferation and death (only 1% of the cells generated in the thymus, mature and migrate to the peripheral tissues). The mechanism of the T-lymphocyte differentiation is believed to involve the interaction of T-lymphocyte precursors with thymic epithelial cells.
- b. **Hormone synthesis.** The Thymic epithelial cells produce hormonal factors (e.g., **thymosin** and **thymopoietin**), which may play an important role in the differentiation of T-lymphocytes.

B. Secondary Lymphoid Tissues

- 1. Spleen: Anatomical organization.** Surrounded by a connective tissue capsule, have the white and the red pulp.

Physiological role. The spleen is the lymphoid organ associated with filtering and clearing of particulate matter, infectious organisms, and aged cells of peripheral blood. Also help the macrophages to process the antigen.

2. Mucosa-Associated Lymphoid Tissues (MALT)

Include the lymphoid tissues of the intestinal tract, genitourinary tract, tracheobronchial tree, and mammary glands. All of the mucosa-associated lymphoid tissues are un-encapsulated and contain both T and B lymphocytes.

3. Gut-Associated Lymphoid Tissue (GALT)

It is found along the digestive tract. Three major sites are the tonsils, the Peyer's patches (located on the submucosa of the small intestine) and the appendix. **Tonsils**, located in the oropharynx, contain mostly B-lymphocytes and are the sites of antigenic stimulation. While, **Peyer's patches**, are lymphoid structures found in the submucosal space of the small intestine.

Physiological roles:

- a. The follicles of the intestinal Peyer's patches are rich with B-cells, which differentiate into IgA-producing plasma cells.
- b. T-lymphocytes are also present in the intestinal mucosa, the most common are memory helper T-cells. This population is involved in the induction of humoral immune responses (HMI).

The lymphatic system

